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Abu al-Wafa' Buzjani

Abū al-Wafāʾ, Muḥammad ibn Muḥammad ibn Yaḥyā ibn Ismāʿīl ibn al-ʿAbbās al-Būzjānī or **Abū al-Wafā Būzhjānī** (Persian: بوژگانی or ابوالوفا بوزجانی)[1] (10 June 940 – 15 July 998) was a Persian[2][3] mathematician and astronomer who worked in Baghdad. He made important innovations in spherical trigonometry, and his work on arithmetics for businessmen contains the first instance of using negative numbers in a medieval Islamic text.

He is also credited with compiling the tables of sines and tangents at 15 ′ intervals. He also introduced the secant and cosecant functions, as well studied the interrelations between the six trigonometric lines associated with an arc.[4] His *Almagest* was widely read by medieval Arabic astronomers in the centuries after his death. He is known to have written several other books that have not survived.

Abu al-Wafa' al-Buzjani	
Born	June 10, 940 Buzhgan, Iran
Died	July 15, 998 (aged 58) Baghdad
Residence	Baghdad
Academic background	
Influences	Al-Battani
Academic work	
Era	Islamic Golden Age
Main interests	Mathematics and Astronomy
Notable works	*Almagest* of Abū al-Wafā'
Notable ideas	Tangent function Law of sines Several trigonometric identities
Influenced	Al-Biruni, Abu Nasr Mansur

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Life

He was born in Buzhgan, (now Torbat-e Jam) in Khorasan (in today's Iran). At age 19, in 959 AD, he moved to Baghdad and remained there for the next forty years, and died there in 998.[4] He was a contemporary of the distinguished scientists Abū Sahl al-Qūhī and Al-Sijzi who were in Baghdad at the time and others like Abu Nasr ibn Iraq, Abu-Mahmud Khojandi, Kushyar ibn Labban and Al-Biruni.[5] In Baghdad, he received patronage by members of the Buyid court.[6]

Astronomy

Abu Al-Wafa' was the first to build a wall quadrant to observe the sky.[5] It has been suggested that he was influenced by the works of Al-Battani as the latter describes a quadrant instrument in his *Kitāb az-Zīj*.[5] His use of tangent helped to solve problems involving right-angled spherical triangles, and developed a new technique to calculate sine tables, allowing him to construct more accurate tables than his predecessors.[6]

In 997, he participated in an experiment to determine the difference in local time between his location and that of al-Biruni (who was living in Kath, now a part of Uzbekistan). The result was very close to present-day calculations, showing a difference of approximately 1 hour between the two longitudes. Abu al-Wafa is also known to have worked with Abū Sahl al-Qūhī, who was a famous maker of astronomical instruments.[6] While what is extant from his works lacks theoretical innovation, his observational data were used by many later astronomers, including al-Biruni.[6]

Almagest

Among his works on astronomy, only the first seven treatises of his *Almagest* (*Kitāb al-Majisṭī*) are now extant.[7] The work covers numerous topics in the fields of plane and spherical trigonometry, planetary theory, and solutions to determine the direction of Qibla.[5][6]

Mathematics

He established several trigonometric identities such as sin(*a* ± *b*) in their modern form, where the Ancient Greek mathematicians had expressed the equivalent identities in terms of chords.[8]

$$\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta$$
$$\sin(a+b) = \sin(a)\cos(b) + \cos(a)\sin(b)$$
$$\cos(2a) = 1 - 2\sin^2(a)$$
$$\sin(2a) = 2\sin(a)\cos(a)$$

He also discovered the law of sines for spherical triangles:

$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c}$$

where *A*, *B*, *C* are the sides (measured in radians on the unit sphere) and *a*, *b*, *c* are the opposing angles.[8]

Some sources suggest that he introduced the tangent function, although other sources give the credit for this innovation to al-Marwazi.[8]

Works

- *Almagest* (كتاب المجسطي *Kitāb al-Majisṭī*).
- A book of zij called *Zīj al-wāḍiḥ* (زيج الواضح), no longer extant.[6]
- "A Book on Those Geometric Constructions Which Are Necessary for a Craftsman", (كتاب في ما يحتاج إليه الصانع من الأعمال الهندسية *Kitāb fī mā yaḥtāj ilayh al-ṣāniʿ min al-aʿmāl al-handasiyya*).[9] This text contains over one hundred geometric constructions, including for a

regular heptagon, which have been reviewed and compared with other mathematical treatises. The legacy of this text in Latin Europe is still debated.[10][11]
- "A Book on What Is Necessary from the Science of Arithmetic for Scribes and Businessmen", (كتاب في ما يحتاج إليه الكتاب والعمال من علم الحساب *Kitāb fī mā yaḥtāj ilayh al-kuttāb wa'l-ʿummāl min ʾilm al-ḥisāb*).[9] This is the first book where negative numbers have been used in the medieval Islamic texts.[6]

He also wrote translations and commentaries on the algebraic works of Diophantus, al-Khwārizmī, and Euclid's *Elements*.[6]

Legacy

- The crater Abul Wáfa on the Moon is named after him.
- On 10 June 2015, Google has changed its logo in memory of Abu al-Wafa' Buzjani.[12]

Notes

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2. Ben-Menahem, A. (2009). *Historical encyclopedia of natural and mathematical sciences* (1st ed.). Berlin: Springer. p. 559. ISBN 978-3-540-68831-0. "970 CE Abu al-Wafa al-Buzjani (940–998, Baghdad). Persian astronomer and mathematician."
3. Sigfried J. de Laet (1994). *History of Humanity: From the seventh to the sixteenth century* (https://books.google.com/books?id=PvlthkbFU1UC&pg=PA931). UNESCO. p. 931. ISBN 978-92-3-102813-7. "The science of trigonometry as known today was established by Islamic mathematicians. One of the most important of these was the Persian Abu' l-Wafa' Buzjani (d. 997 or 998), who wrote a work called the Almagest dealing mostly with trigonometry"
4. O'Connor, John J.; Robertson, Edmund F., "Mohammad Abu'l-Wafa Al-Buzjani" (http://www-history.mcs.st-andrews.ac.uk/Biographies/Abu'l-Wafa.html), *MacTutor History of Mathematics archive*, University of St Andrews.
5. Moussa, Ali (2011). "Mathematical Methods in Abū al-Wafāʾ's Almagest and the Qibla Determinations". *Arabic Sciences and Philosophy*. Cambridge University Press. **21** (1): 1–56. doi:10.1017/S095742391000007X (https://doi.org/10.1017%2FS095742391000007X).
6. Hashemipour 2007.
7. Kennedy, E. S. (1956). *Survey of Islamic Astronomical Tables*. American Philosophical Society. p. 12.
8. Jacques Sesiano, "Islamic mathematics", p. 157, in Selin, Helaine; D'Ambrosio, Ubiratan, eds. (2000), *Mathematics Across Cultures: The History of Non-western Mathematics*, Springer, ISBN 1-4020-0260-2
9. Youschkevitch 1970.
10. Raynaud 2012.
11. Gamwell, Lynn (2 December 2015). "Why the history of maths is also the history of art" (https://www.theguardian.com/science/alexs-adventures-in-numberland/2015/dec/02/why-the-history-of-maths-is-also-the-history-of-art). The Guardian. Retrieved 3 December 2015.
12. "Abu al-Wafa' al-Buzjani's 1075th Birthday" (https://www.google.com/doodles/abu-al-wafa-al-buzjanis-1075th-birthday). *Google*. 10 June 2015.

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External links

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